REMARKS

Submitted herewith is a Petition for Extension of Time, extending the time for response from December 12, 2003 to February 12, 2004.

As a result of this amendment, claims 1-12, 19, 20, 24, and 27-41 are now in the application.

The objection to claim 17 as having an improper dependency has been noted and has been obviated by its cancellation.

Original claim 1 was rejected under 35 USC 102(e) as being anticipated by Hung et al. (6,329,738), claims 25-27 were rejected under 35 USC 103(a) as being unpatentable over Hung et al, and the remaining claims were rejected under 35 USC 103(a) as being unpatentable over Hung et al. in view of Kim et al. (NANOTUBE NANOTWEEZERS). In rejecting those claims, the Examiner noted that certain of the claims were defective because of process limitations. Certain of the objected language have been eliminated by this amendment.

Applicant respectfully requests reconsideration of the subject application on the ground that the subject invention is neither anticipated nor rendered obvious by Hung et al., whether taken alone or together with Kim et al. or any of the other references of record. In furtherance of this request for reconsideration, Applicant has cancelled certain of the original claims, modified other original claims to better define the invention, and added certain new claims to provide adequate coverage of the invention.

The essence of Applicant's invention is the concept of providing a nanoscale grasping device for manipulation of microscopic objects characterized by the presence of three or more electrically-conductive elongate grasping elements attached to electrodes mounted on a substrate, with the electrodes serving to permit application of voltages to electrostatically cause the free ends of the grasping elements to move toward or away from one another. In a preferred embodiment the grasping elements are carbon nanotubes. Additionally, the invention contemplates use of oscillating voltages to control operation of the grasping elements and to overcome operating

limitations of the Kim et al construction. A variety of operating voltage modes are set forth in the specification. One advantage of using oscillating voltages is that resonant vibrations in the grasping elements can be cancelled by virtue of the oscillating voltages being out of phase with one another.

The patent to Hung et al. does not disclose a grasping device as described and illustrated in the present application. Instead, Hung et al. disclose an electrostatically controllable actuator having a stationary electrode and an actuating element separated from the stationary electrode by an actuation gap and having a conducting actuation region, whereby when an actuation voltage is applied between the actuation region and the stationary electrode, the actuating element can be displaced as a result of electrostatic forces. The actuating elements of Hung et al. are essentially beams that extend parallel to a support that includes the stationary electrode. The flexible beam carries an electrode, so that when a voltage is applied between the electrode on the support and the electrode on the beam, an electrostatic force attracts the beam and causes it to be deflected toward the stationary support. Thus the device of Hung et al. lacks grasping elements as called for by Applicant's claims.

More specifically with respect to Hung et al., the Examiner has noted the disclosure in column 22, lines 25-38 as allegedly disclosing three electrostatically actuated grasping elements 92, 94, 96 and 98. However, the elements 92, 94, 96 and 98 are cantilever beams each suspended over a substrate 14 (Figs. 17A, 17B). The construction shown in Figs. 17A and 17B is not like that disclosed by Applicant, since the deflecting beams 92-98 are anchored at one end to posts that are connected to the substrate 14 and at the other end to posts118-124 that support the member 126. In point of fact, Fig. 1A of Hung et al. is closer to Applicant's invention in that the beam 10 is a cantilever beam having one end attached to a support post 12 and the other end free to deflect in response to electrostatic forces.

However, the Hung et al. reference is not directed to grasping an object with a plurality of grasping elements and does not teach or suggest the concept of having grasping elements that are capable of coacting with one another to grasp and subsequently to release an object.. In fact, the elements 92-98 of Hung et al. do not

actuate with respect to each other, but instead are actuated with respect to individual stationary electrodes, with the resultant motion being restricted to the line between the element and the electrode. The elements 92-98 of Hung et al. have only one degree of freedom, and the same is true of the cantilever beam shown in Fig. 1A of Hung et al. In contrast, the grasping elements of Applicant's device have two degrees of freedom of movement. Furthermore, as noted in paragraph 5 of the Official Action, Hung et al. do not show grasping elements made of a fibrous material. To overcome the deficiencies of Jung et al. the Examiner has referred to Kim et al.

Kim et al disclose a tweezer device having grasping elements made of a fibrous material. However, Applicant submits that the Examiner has no reasonable basis in fact for concluding that it "would have been obvious to one having ordinary skill in the art at the time that the invention was made to modify the device of Hung et al. by providing grasping elements made of a fibrous material in order to provide remarkable mechanical toughness and electrical conductivity in view of the teachings of Kim et al." That conclusion by the Examiner is defective in that the actuating device of Hung et al. does not have grasping elements and modifying that device to provide it with grasping elements made of a fibrous material would render the device inoperative for its original intended purpose. Furthermore, the basic construction of the Hung et al. device is so different from the tweezer device of Kim et al. as to dispel any notion that it would be obvious to persons skilled in the art to modify the device of Hung et al. in a manner taught by Kim et al. so as to provide a grasping device as called for by Applicant's claims.

Kim et al. also is deficient in that it does not teach or suggest the concept of utilizing more than two grasping elements. As pointed out in Applicant's specification, having more than two grasping elements provides a measure of control that is not attainable by the device of Kim et al. Another important aspect of the Kim et al tweezer is that it is operated by a dc voltage. The tips of the tweezers snap closed once the applied dc voltage reaches a critical value. At that critical voltage, the voltage-distance relationship exhibits a discontinuous step change. Therefore, the tip motion, as actuated by a dc field, is not well controlled. Furthermore the tips remain closed until a

common voltage is applied to both tips. Applicant's concept of using an alternating voltage offers the advantage that the phase rotation precludes the "snapping" effect that Kim describes. Furthermore the net effect of the time-varying, phased voltage allows each grasping element to be directed toward any point within the plane or volume defined by the three or more grasping elements.

A further distinction in relation to Kim et al. is how the grasping elements are anchored. In this connection it is to be noted that applicant's nanofiber grasping elements are attached directly to the electrodes. In its preferred embodiment Applicant's grasping elements are grown onto the electrodes using a selected catalyst as a seed for direct growth of the grasping elements. In contrast to Applicant's invention, the grasping elements of Kim et al. are pre-fabricated and then attached to the substrate. More specifically, the Kim et al. nanotubes are attached to glass pipettes which in turn are attached to the electrodes. Kim et al do not teach or suggest the concept of growing the fibrous grasping elements on the electrodes formed on the substrate.

Applicant's claims distinguish from Hung et al and Kim et al in various ways, as set forth below.

Claim 1 is patentable since it calls for at least three electrodes on a substrate and at least three elongate grasping elements, with each grasping element having one end attached to an electrode and the other end projecting outwardly away from the substrate. This combination is new with applicant and is not obvious from the references for the reasons advanced above.

Claims 2-12, 19, 20, 24, 28 and 29 all depend from claim 1 and are patentable for the same reasons. They also contain other limitations that further distinguish the claimed invention from the prior art. In this connection it is to be noted that the functional language objected to by the Examiner has been replaced by other language that is believed to be free of that informality. Thus, for example, claims 9-12, 19, 20 and 24 call for voltages on the electrodes and claims 28 and 29 employ the word "adapted" to render definite the "use" limitations of the claimed structure.

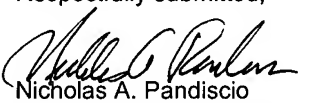
New claims 30-32 and 34 are similar to claim 1 and certain of its dependent claims and are believed to be patentable for the same reasons.

Claim 33 is believed patentable since it depends from claim 32 and adds limitations as to the size of the carbon nanotubes.

Claims 35-41 are method claims and are believed to define a novel and patentable invention, particularly with respect to calling for a grasping device having at least three grasping elements and the use of oscillating voltages to electrostatically manipulate the grasping elements.

It is believed that this constitutes a full and complete response to the official action. Therefore, prompt and favorable reconsideration is solicited.

Respectfully submitted,



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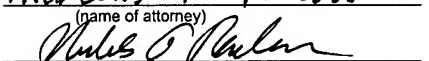
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